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ADVERTISEMENT CALLS OF FOUR HYLID FROGS FROM THE STATE OF BAHIA, NORTHEASTERN BRAZIL (AMPHIBIA, ANURA, HYLIDAE)

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Abstract: We describe the advertisement calls of *Dendropsophus branneri, Phyllodytes melanomystax,* and *Scinax agilis,* and present new information on the advertisement call of *Scinax auratus.* We also describe the territorial call of *P. melanomystax.* We provide the power spectrums, audiospectrograms, and waveforms of all calls. Vocalizations were recorded in the Municipalities of Camaçari, Elísio Medrado, Feira de Santana, and Mata de São João, State of Bahia, Brazil. Based on the advertisement call characteristics of these species, we discuss some aspects related to their taxonomy.

Keywords: Anura, Hylidae, *Dendropsophus branneri, Phyllodytes melanomystax, Scinax agilis, Scinax auratus,* acoustic communication, taxonomy.

Introduction

Advertisement calls in anurans (*sensu* Wells, 1977) are conspicuous and used in species-specific acoustic communication (Duellman and Trueb, 1994; Gerhardt, 1994). Males announce their location and reproductive status to females and also to other males through the advertisement call (Duellman and Trueb, 1994; Gerhardt and Huber, 2002). Due to its specificity, the anuran advertisement call has been used as a diagnostic character for clarifying the taxonomy among closely related species (e.g. Heyer *et al.,* 1990; Sullivan and Malmos, 1994; Pombal *et al.,* 1995; Sullivan *et al.,* 1996; Abrunhosa *et al.,* 2005; Napoli and Cruz, 2005; Silva-Filho and Juncá, 2006).

Hylidae is a large frog family of American, Australopapuan, and temperate Eurasian treefrogs of approximately 814 known species (Faivovich *et al.,* 2005; Frost, 2006; Frost *et al.,* 2006). Recently, the sub-family Hylinae was reviewed (Faivovich *et al.,* 2005), and many species previously allocated in the genus *Hyla* received new generic status. The study of Faivovich *et al.* (2005) provides a general framework for the study of relationships of sub-families, genera and major species groups of Hylidae. This new classification was followed by subsequent authors (e.g., Frost *et al.,* 2006). However, the relationships within smaller taxonomic units of many hylid genera are not well-delimited and vocalizations (mainly advertisement calls) can be used to resolve the relationships among species (e.g., Abrunhosa *et al.,* 2005; Napoli and Cruz, 2005; Silva-Filho and Juncá, 2006).

Our investigation focused on the advertisement calls of four species of Neotropical hylids: *Dendropsophus branneri* (Cochran, 1948), *Phyllodytes melanomystax* Caramaschi, Silva and Britto-Pereira, 1999, *Scinax agilis* (Cruz and Peixoto, 1983), and *S. auratus* (Wied-Neuwied, 1821), and the contribution of call data to the understanding of the taxonomy of the involved species. In addition, we also decribe a territorial call of *P. melanomystax.*

Material and Methods

Anuran vocalizations were recorded during fieldwork developed in Arembepe, Municipality of Camaçari (12°41'51"S; 38°19'27"W), Serra São José, Municipality of Feira de Santana (12°16'00"S; 38°58'00"W), Serra da Jibóia, Municipality of Elísio Medrado (12°56'47"S; 39°31'18"W), and Reserva Sapiranga, Municipality of Mata de São João (12°31'49"S; 38°17'57"W), State of Bahia, Brazil. Calls were obtained with a Sony WM-D6 Digital Audio Tape (DAT) recorder coupled to a Sony ECM-MS907 Electret Condenser Microphone. We analyzed advertisement calls in a Macintosh Computer using Canary 1.2.4 software (Charif *et al.,* 1995). Calls were digitized at a sample rate of 44.1 Hz, sample size of 16 bits. Voucher specimens were deposited in the Museu de Zoologia of Universidade Estadual de Feira de Santana (MZUEFS) and the advertisement calls were deposited in the collection of sound recordings of Universidade Estadual de Feira de Santana (SUEFS). Call classification

and call components terminology follow Duellman and Trueb (1994). We measured the temporal parameters directly from the waveform. To determine the dominant frequency we used the audiospectrogram and spectrum analysis of Canary 1.2.4, with filter band-width of 174.85 Hz, frame length of 1024 points, grid resolution time of 1.451 ms, 93.75% overlap, grid resolution frequency of 43.07 Hz, FFT size with 1024 points, window function hamming, amplitude logarithmic, and clipping level of -80 dB. We evaluated the call amplitude modulation from visual inspection of expanded waveform displays and determined the frequency modulation using both expanded audiospectrogram displays and power spectrum analysis displays.

Results

Dendropsophus branneri (Cochran, 1948)

We recorded two individuals at Serra São José, Municipality of Feira de Santana (MZUEFS 1751/ SUEFS 10.4; unvouchered specimen/SUEFS 10.2), calling on emergent vegetation at 60 cm from water surface, and six individuals from Reserva Sapiranga, Municipality of Mata de São João (MZUEFS 577/ SUEFS 2.11; MZUEFS 578/SUEFS 2.14; MZUEFS 579/SUEFS 2,16; MZUEFS 580/SUEFS 2.9; MZUEFS 581/SUEFS 2.8; MZUEFS 582/SUEFS 2.10), calling on the marginal vegetation of streams and ponds at approximately 50 cm from water surface.

The advertisement call is simple (Fig. 1A, B) and formed by a single note with three to five pulses ($\bar{x}$ = 4; SD = 1.0; N = 180 notes) (Fig. 1A, B). Call duration ranged from 0.01 to 0.04 s ($\bar{x}$ = 0.03; SD = 0.002; N = 180 calls) and call interval ranged from 0.18 to 0.97 s ($\bar{x}$ = 0.37; SD = 0.21; N = 173 intervals). In five occasions, the call interval reached 2.25 s ($\bar{x}$ = 1.33; SD = 0.53). Dominant frequency ranged from 5.90 to 6.64 kHz ($\bar{x}$ = 6.35; SD = 0.15; N = 180 notes) (Fig. 1C). The last pulse presented little descendant amplitude modulation (Fig. 1B).

Phyllodytes melanomystax Caramaschi, Silva and Britto-Pereira, 1999

We recorded two individuals at Reserva Sapiranga, Municipality of Mata de São João (MZUEFS 588/SUEFS 2.1, MZUEFS 603/SUEFS 9.8) and one individual at Serra da Jibóia, Municipality of Elísio Medrado (MZUEFS 583/SUEFS 2.12), all calling in the axils of bromeliads. The specimen MZUEFS 588 was recorded with other adult and a younger on the other side of the same bromeliad.

The advertisement call (Fig. 2A, B, F, G, H) is a single harmonic note, generally with three visible harmonics in the sonogram (Fig. 2F). Mean duration was 0.07 s (SD = 0.04, N = 51 notes). Dominant frequency oscillated between the fundamental frequency ($\bar{x}$ = 1.39 kHz; SD = 0.05; N = 36 calls) and the second harmonic ($\bar{x}$ = 3.11 kHz; SD = 0.25; N = 31 calls) (Fig. 2H). Because of the narrow band filter analyses, figure 2F shows artifacts in the beginning and in the end of the call (see Vielliard, 1993). Intercall interval ranged from 11.18 to 54.29 s ($\bar{x}$ = 28.81; SD = 12.48; N = 47 intervals).

The territorial call (Fig. 2A, B, C, D, E), consists of an initial multipulsed note, containing 26 to 28 pulses (Fig. 2C, D), always followed by the advertisement calls. The duration ranged from 0.19 to 0.26 s. Dominant frequency ranged from 3.40 to 3.76 kHz ($\bar{x}$ = 3.49; SD = 0.12; N = 2 calls) (Fig. 2E). We heard specimens of *P. melanomystax* emitting the two calls in both localities; however, we were able to record only two calls from a single specimen from Reserva Sapiranga (MZUEFS 588/SUEFS 2.1).

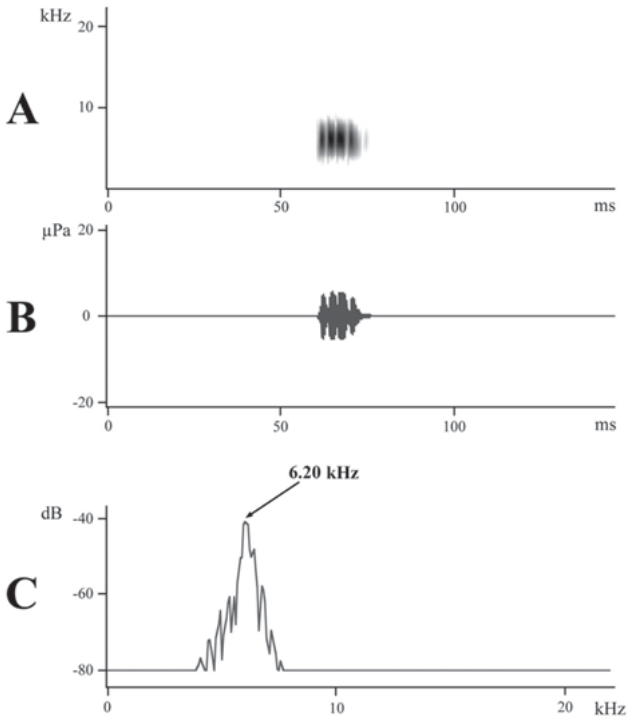

Figure 1: Advertisement call of *Dendropsophus branneri,* recorded on 29 January, 2004. Air temperature 24°C and water temperature 26°C: (A) audiospectrogram; (B) waveform; (C) power spectrum.

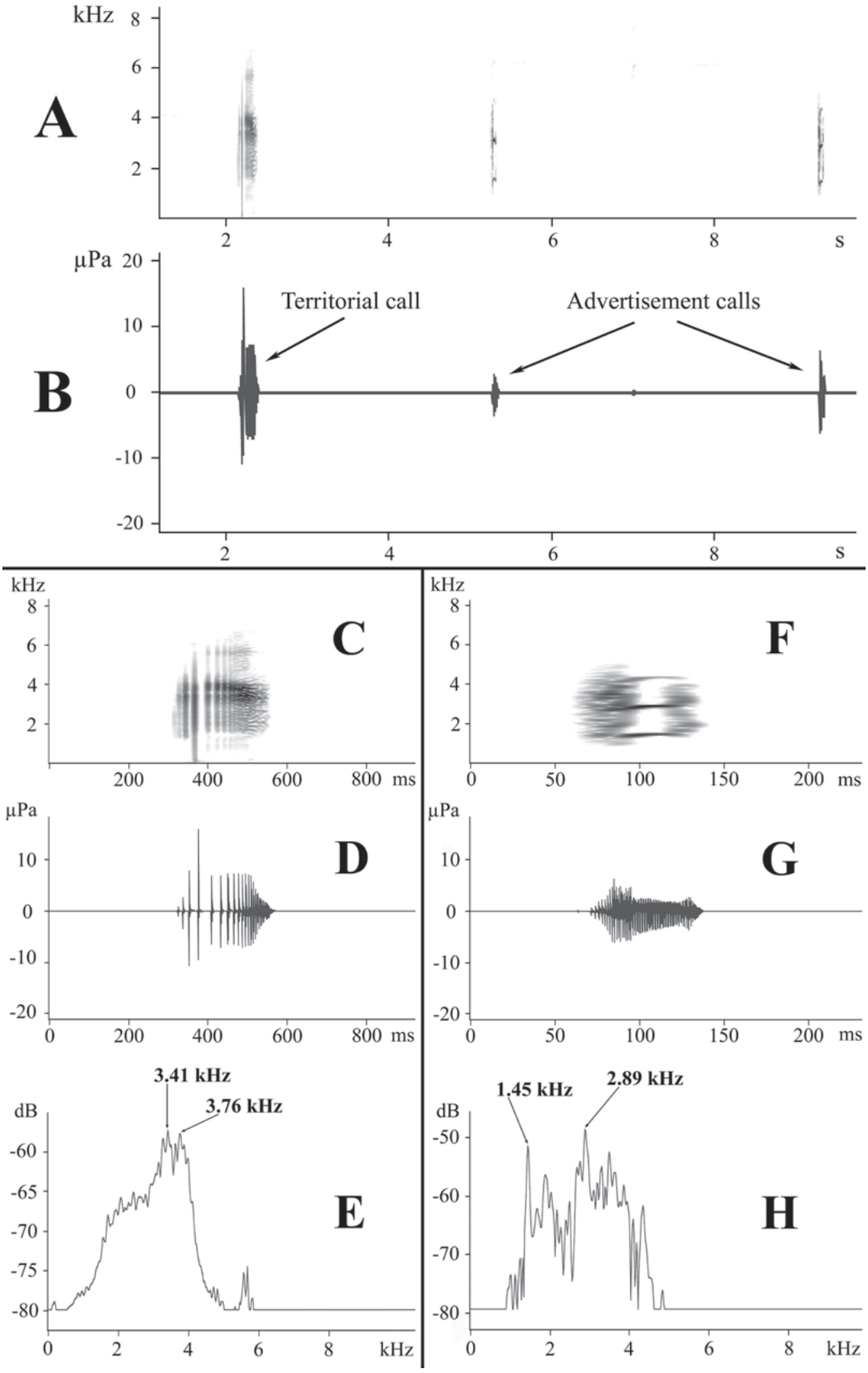

FIGURE 2: Advertisement call of *Pyllodytes melanomystax,* recorded on 21 July, 2001, showing the advertisement and territorial calls. Air temperature 23°C and water temperature 23°C: (A) audiospectrogram, (B) waveform. Detail of territorial call: (C) audiospectrogram, (D) waveform; (E) power spectrum. Detail of advertisement call: (F) audiospectrogram, (G) waveform; (H) power spectrum.

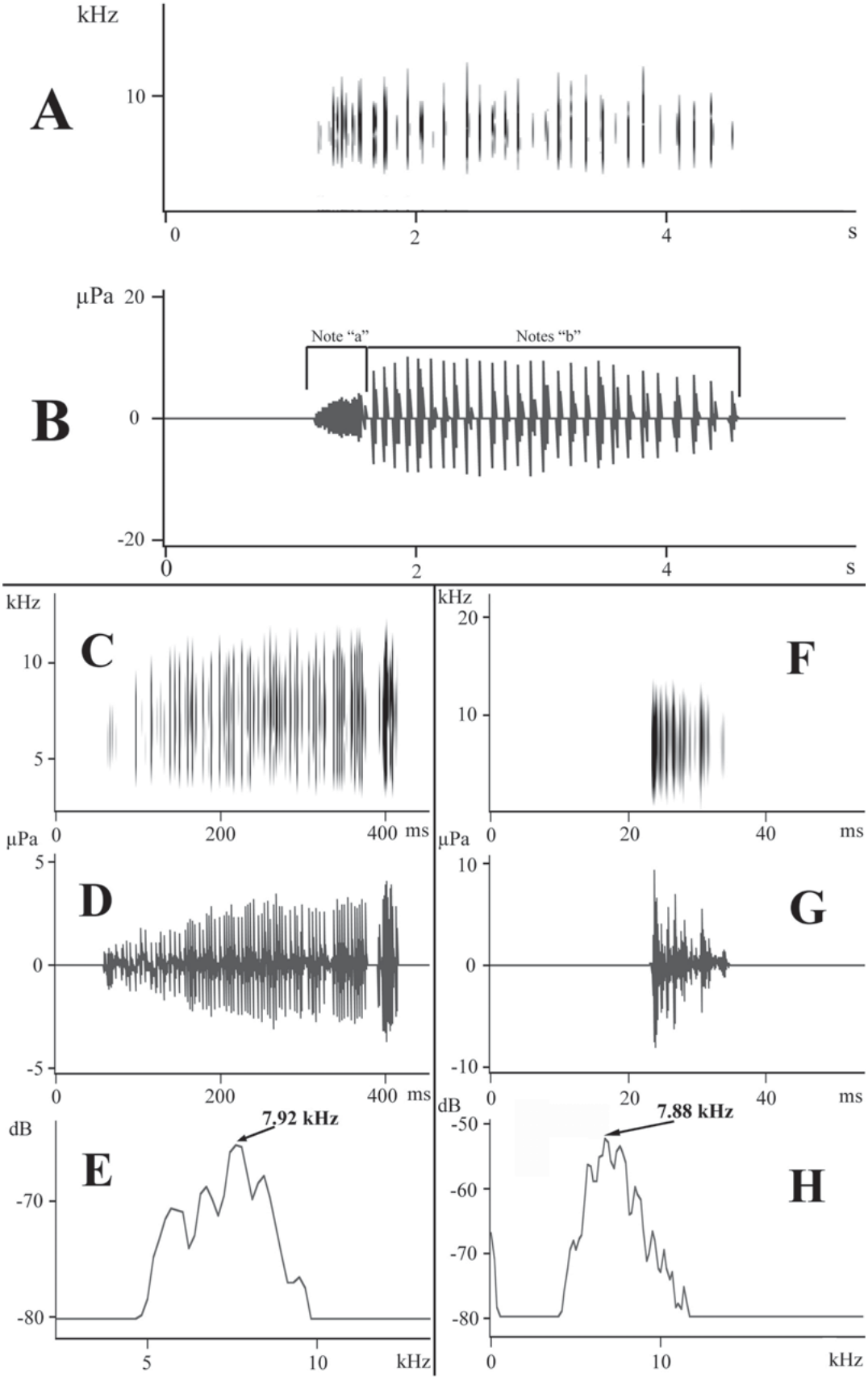

FIGURE 3: Advertisement call of *Scinax agilis,* recorded on 21 July, 2001, showing notes types "a" and "b". Air temperature 23°C and water temperature 23°C: (A) audiospectrogram; (B) waveform. Detail of note "a": (C) audiospectrogram, (D) waveform; (E) power spectrum. Detail of note "b": (F) audiospectrogram, (G) waveform; (H) power spectrum.

Scinax agilis (Cruz and Peixoto, 1983)

We recorded two individuals calling from a bush, 1 m above the ground, on a wetland at Arembepe, Municipality of Camaçari (unvouchered specimens/ SUEFS 11.10, 1.11).

The advertisement call (Fig. 3A, B) is a combination of two different notes, here called notes "a" (Fig. 3C, D, E) and "b" (Fig. 3F, G, H). Notes "a" and "b" are always emitted in sequence: a single initial note "a" is followed by 13 to 29 notes "b" ($\bar{x}$ = 23.27, SD = 5.87, N = 12 calls). Note "a" is multipulsed, formed by 74 to 96 pulses ($\bar{x}$ = 85.67; SD = 5.07; N = 12 notes) (Fig. 3C, D). Its duration ranged from 0.38 to 0.40 s ($\bar{x}$ = 0.39; SD = 0.76; N = 12 notes), pulse duration was shorter than 1.0 ms and the interval between pulses ranged from 1.06 to 20.31 ms ($\bar{x}$ = 3.67; SD = 2.20; N = 348). Pulses may also appear aggregated at the end of note "a" (Fig. 3C, D). Dominant frequency of note "a" ranged from 7.45 to 7.92 kHz ($\bar{x}$ = 7.66; SD = 0.18; N = 12 notes) (Fig. 3E). Each note "b" is also a multipulsed note, with five to 11 pulses ($\bar{x}$ = 7.15; SD = 1.22; N = 104 notes) (Fig. 3F). Note "b" duration ranged from 10.6 to 32.0 ms ($\bar{x}$ = 25.1; SD = 5.3; N = 104 notes), and the interval between notes ranged from 62.4 to 133.5 ms ($\bar{x}$ = 80.1; SD = 14.5; N = 94 intervals). Pulse duration was shorter than 1.0 ms and the interval between pulses ranged from 1.01 to 23.79 ms ($\bar{x}$ = 5.51; SD = 6.70; N = 140 intervals). Dominant frequency of note "b" ranged from 5.60 to 7.88 kHz ($\bar{x}$ = 7.02; SD = 0.48; N = 104 notes) (Fig. 3H). The interval between note "a" and the following note "b" ranged from 58.22 to 76.44 ms ($\bar{x}$ = 67.07; SD = 9.22; N = 12 intervals).

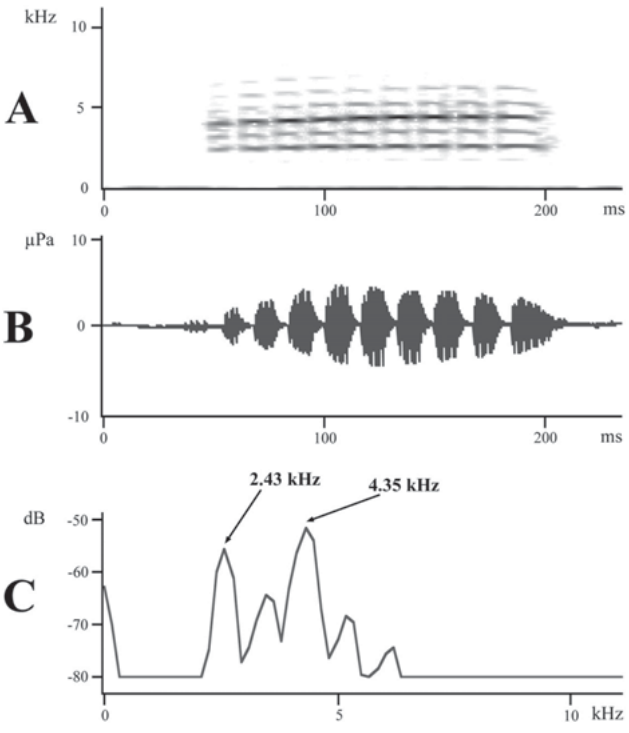

FIGURE 4: Advertisement call of *Scinax auratus,* recorded on 13 November, 2003. Air temperature 24°C and water temperature 27°C: (A) audiospectrogram; (B) waveform; (C) power spectrum.

Scinax auratus (Wied-Neuwied, 1821)

We recorded one individual from Serra São José, Municipality of Feira de Santana (unvouchered specimen/SUEFS 7.9), calling from a bush 20 cm from the water surface, and two individuals from Reserva Sapiranga, Municipality of Mata de São João (unvouchered specimen/SUEFS 1.132; MZUEFS 1259/SUEFS 13.13), calling from a bush 0.20 and 120 cm above the ground, respectively, near temporary ponds.

The advertisement call is simple and comprised of nine notes (Fig. 4A, B, C). The call duration ranges from 0.15 to 0.22 s ($\bar{x}$ = 0.19; SD = 0.04; N = 45 calls) (Fig. 4B), being emitted in short intervals of 0.91 to 1.69 s ($\bar{x}$ = 1.15; SD = 0.29; N = 14 intervals) or longer intervals of 2.55 to 3.98 s ($\bar{x}$ = 3.34; SD = 0.73; N = 5 intervals). The first note was shorter than the others (Fig. 4B), with the first note duration ranging from 9.03 to 11.81 ms ($\bar{x}$ = 10.28; SD = 0.89; N = 20 notes) and the notes 2 to 8 duration ranging from 11.34 to 16.90 ms ($\bar{x}$ = 14.10; SD = 1.00; N = 140 notes). The last note was longer than the others (Fig. 4B), with duration ranging from 18.98 to 26.62 ms ($\bar{x}$ = 21.67; SD = 2.38; N = 20 notes). The call has harmonic structure, ranging from five to six harmonics ($\bar{x}$ = 5.85; SD = 0.37; N = 45 calls) (Fig. 4A). The dominant frequency ranges from 4.00 to 4.35 kHz ($\bar{x}$ = 4.19; SD = 0.05; N = 45 calls), on the third visible harmonic (Fig. 4A, C). The call does not have amplitude modulation (Fig. 4A) or frequency modulation (Fig. 4B).

DISCUSSION

Dendropsophus branneri belongs to the *D. microcephalus* group, a monophyletic group containing 33 species with unresolved phylogenetic relationships (Faivovich *et al.,* 2005). The advertisement call of *D. branneri* differs from the known vocalizations of other species in the *D. microcephalus* group (sensu Faivovich *et al.,* 2005): *D. cruzi* (Cochran, 1948) (see

Pombal and Bastos, 1998), *D. decipiens* (Lutz, 1925) (see Abrunhosa *et al.,* 2001), *D. meridianus* (Lutz, 1954) (see Pombal and Bastos, 1998), *D. microcephalus* (Cope, 1886) (see Duellman and Fouquette, 1968), *D. nanus* (Boulenger, 1889) (see Bastos *et al.,* 2003), and *D. werneri* (Cochran, 1952) (see Lingnau *et al.,* 2004). The call duration of *D. branneri* ($\bar{x}$ = 0.37 s) is longer than in *D. cruzi* ($\bar{x}$ = 0.007 s), *D. meridianus* ($\bar{x}$ = 0.016 s), and *D. nanus* ($\bar{x}$ = 0.031 s), and shorter than in *D. decipiens* ($\bar{x}$ = 1.10 s) and *D. werneri* ($\bar{x}$ = 0.52 s). The number of notes in *D. branneri* (N = 1 note) is smaller than for *D. microcephalus* (N = 2 notes), *D. werneri* ($\bar{x}$ = 4.06 notes), and *D. decipiens* ($\bar{x}$ = 7.31 notes). The dominant frequency in *D. branneri* ($\bar{x}$ = 6.15 kHz) is higher than in *D. decipiens* (4.77-5.33 kHz), *D. microcephalus* ($\bar{x}$ = 5.64 kHz), and *D. nanus* ($\bar{x}$ = 4.18 kHz), but is lower than in *D. werneri* ($\bar{x}$ = 6.75 kHz). According to Lutz (1973), *D. branneri* is the closest species to *D. decipiens* (as mentioned by Bokermann, 1963) and that these two species may be synonymized when the gaps in distribution were filled. The results of the present study corroborates the hypothesis of full species status of *D. branneri* (see Bastos and Pombal, 1996). However, *D. branneri* is unassigned to any group (Faivovich *et al.,* 2005; Frost *et al.,* 2006) and seems to be a complex of species, pending taxonomic review.

There are few advertisement calls described for the species of the genus *Phyllodytes*. Only *P. kautskyi* Peixoto and Cruz, 1988 and *P. luteolus* (Wied-Neuwied, 1824) have calls described by Simon and Gasparini (2003) and Weygoldt (1981), respectively. The call duration in *P. melanomystax* ($\bar{x}$ = 0.07 s) is shorter than in *P. kautskyi* ($\bar{x}$ = 3.55 s) and *P. luteolus* ($\bar{x}$ = 5.00 s). *Phyllodytes melanomystax* presents the same number of notes (N = 1 note) as in *P. kautskyi* (N = 1 note) and less notes than *P. luteolus* (N = 7-20 notes). The dominant frequency in *P. melanomystax* ($\bar{x}$ = 1.39 or 3.11 kHz) can be higher than in *P. kautskyi* (0.87–1.81 kHz) and lower than in *P. luteolus* ($\bar{x}$ = 3.00 kHz). The advertisement calls of *Phyllodytes melanomystax* and *P. luteolus* did not show frequency modulation, whereas *P. kautskyi* show ascendant modulation in the first half and descendant in the second half of the call. *Phyllodytes kautskyi, P. luteolus,* and *P. melanomystax* are currently assigned to the *P. luteolus* species group (sensu Faivovich *et al.,* 2005; unchanged in Frost *et al.,* 2006).

According to the original description, *Scinax agilis* is related with *S. berthae* (Cruz and Peixoto, 1983). Faivovich (2002) included *S. berthae* and *S. agilis* in the *S. catharinae* species group. The sample of the advertisement call of *S. berthae* available on commercial cassette tape (Straneck *et al.,* 1990) revealed different acoustical parameters from the advertisement call of *S. agilis*. The advertisement call of *S. agilis* differ from *S. berthae* by presenting two different notes (one single note in *S. berthae*), longer call duration ($\bar{x}$ = 0.051 s in *S. berthae*), and higher dominant frequency (5.60-7.88 kHz in *S. agilis* and 4.33-4.833 kHz in *S. berthae*).

The advertisement call of *Scinax auratus* was previously described by Bokermann (1969), from the type locality, the Municipality of Santa Inês, State of Bahia, Brazil. The acoustic parameters are similar to those presented by Bokermann (1969), but the author indicates three harmonics with higher intensity, without determining the dominant frequency accurately. *Scinax auratus* is similar to *S. crospedospilus* (A. Lutz, 1925), *S. cuspidatus* (A. Lutz, 1925) and *S. alter* (B. Lutz, 1973) with respect to many morphological features (Lutz, 1973; Duellman and Wiens 1992), including tadpole morphology (Alves *et al.,* 2004). However, the call duration of *S. auratus* (0.15-0.16 s) is longer than in *S. cuspidatus* (0.12-0.15 s; Pombal *et al.,* 1995) and shorter than in *S. alter* (0.38-2.07 s; Pombal *et al.,* 1995) and *S. crospedospilus* (0.25-0.32 s; Heyer *et al.,* 1990). The number of notes in *S. auratus* (N = 9 notes) is larger than in *S. alter, S. cuspidatus* (one single note in both species; Pombal *et al.,* 1995), and *S. crospedospilus* (N = 5-7 notes; Heyer *et al.,* 1990). Dominant frequency in *S. auratus* (4.00-4.34 kHz) is higher than in *S. crospedospilus* (1.2-1.5 kHz; Heyer *et al.,* 1990) and *S. cuspidatus* (2.32-2.37 kHz; Haddad *et al.,* 2005), and lower than in *S. alter* (4.78-4.95 kHz; Haddad *et al.,* 2005).

According to Pombal and Bastos (2003), multipulsed notes are widespread in the genus *Scinax,* with vocalizations of the *Scinax ruber* species group (*sensu* Duellman and Wiens, 1992) characterized by pulsed structure, and vocalizations of the *Scinax catharinae* species group (*sensu* Duellman and Wiens, 1992) characterized by short notes, sometimes with harmonic structure. In a review of the genus *Scinax,* Faivovich (2002) recognized the *Scinax catharinae* and *Scinax ruber* clades. The later includes all members of the former *S. ruber* species group, all representatives of the *Scinax rostratus* species group and some representatives of the *S. staufferi* species group (*sensu* Duellman and Wiens, 1992). Subsequently, Faivovich *et al.,* (2005) recognized the *Scinax catharinae* and *Scinax perpusillus* species groups within

the *Scinax catharinae* clade, and *Scinax rostratus* and *Scinax uruguayus* species groups within the *Scinax ruber* clade. However, species of the *Scinax ruber* and *Scinax staufferi* groups (*sensu* Duellman and Wiens, 1992), including *S. auratus,* were not assigned to any species group. Thus, the distinction between the species groups of *Scinax* presented in Pombal and Bastos (2003) does not agree with the current taxonomic proposal (Faivovich *et al.* 2005), but could provide insights to future studies with more inclusive clades of the genus.

Resumo

São descritos os cantos de anúncio de *Dendropsophus branneri, Phyllodytes melanomystax* e *Scinax agilis* e apresentadas novas informações sobre o canto de anúncio de *Scinax auratus*. É descrito também o canto territorial de *P. melanomystax*. São apresentados espectrogramas, sonogramas e oscilogramas das vocalizações. As vocalizações foram gravadas nos Municípios de Camaçari, Elísio Medrado, Feira de Santana e Mata de São João, Estado da Bahia, Brasil. A partir das características dos cantos de anúncio destas espécies, discutimos alguns aspectos relacionados à sua taxonomia.

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Literature Cited

Abrunhosa, P. A., H. Wogel, and J. P. Pombal Jr. 2001. Vocalização de quatro espécies de anuros do Estado do Rio de Janeiro, Sudeste do Brasil (Amphibia, Hylidae, Leptodactylidae). Boletim do Museu Nacional (N.S.) Zoologia, 2001(472):1-12.

Abrunhosa, P. A., B. V. S. Pimenta, C. A. G. Cruz, and C. F. B. Haddad. 2005. Advertisement calls of species of the *Hyla albosignata* group (Amphibia, Anura, Hylidae). Arquivos do Museu Nacional, 63(2):275-282.

Alves, A. C. R., M. R. Gomes, and S. P. Carvalho-e-Silva. 2004. Description of the tadpole of *Scinax auratus* (Wied-Neuwied) (Anura, Hylidae). Revista Brasileira de Zoologia, 21(2):315-317.

Bastos, R. P. and J. P. Pombal Jr. 1996. A new species of *Hyla* (Anura: Hylidae) from eastern Brazil. Amphibia-Reptilia, 17(3):325-331.

Bastos, R. P., M. A. F. Bueno, S. L. Dutra, and L. P. Lima. 2003. Padrões de vocalização de anúncio em cinco espécies de Hylidae (Amphibia: Anura) do Brasil Central. Comunicação do Museu de Ciências e Tecnologia da PUCRS, Série Zoologia, 16(1):39-51.

Bokermann, W. C. A. 1963. Nova espécie de *Hyla* da Bahia, Brasil (Amphibia, Salientia). Atas da Sociedade Biológica do Rio de Janeiro, 7(2):6-8.

Bokermann, W. C. A. 1969. Notas sobre *Hyla aurata* Wied, 1824 (Anura, Hylidae). Revista Brasileira de Biologia, São Carlos, 29(2):159-162.

Charif, R. A., S. Mitchell, and C. W. Clark. 1995. Canary 1.2.4 user's manual. Cornell Laboratory of Ornithology, Ihaca, New York, 229pp.

Cruz, C. A. G. and O. L. Peixoto. 1983. Uma nova espécie de *Hyla* do Estado do Espírito Santo, Brasil (Amphibia, Anura, Hylidae). Revista Brasileira de Biologia, 42(4):721-724.

Duellman, W. E. and M. J. Fouquette Jr. 1968. Middle American frogs of the *Hyla microcephala* group. University of Kansas – Publications of Natural History, 17(12):517-557.

Duellman, W. E. and L. Trueb. 1994. Biology of Amphibians. McGraw-Hill Book Company, New York, 670pp.

Duellman, W. E. and J. J. Wiens. 1992. The status of the hylid frog genus *Ololygon* and the recognition of *Scinax* Wagler, 1830. Occasional Papers of the Museum of Natural Hystory of The University of Kansas, 1992(151):1-23.

Faivovich, J. 2002. A cladistic analysis of *Scinax.* Cladistics, 18(4):367-393.

Faivovich, J., C. F. B. Haddad, P. C. A. Garcia, D. R. Frost, J. A. Campbell, and W. C. Wheeler. 2005. Systematic review of the frog family Hylidae, with special reference to Hylinae: phylogenetic analysis and taxonomic revision. Bulletin of the American Museum of Natural History, 2005(294):1-240.

Frost, R. D. 2006. Amphibian Species of the World: an Online Reference. Version 4. Available from http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York, USA. Accessed 18 September 2006.

Frost. D.R.; G. Taran; J. Faivovich; R.H. Bain; A. Haas; C.F.B. Haddad; R.O. de Sá; A. Channing; M. Wilkinson; S.C. Donnellan; C.J. Raxworthy; J.A. Campbell; B.L. Blotto; P. Moler; R.C. Drewes; R.A. Nussbaum; J.D. Lynch; D. Green, and W.D. Wheeler. 2006. The Amphibian tree of life. Bulletin of the American Museum of Natural History, 2006(297):1-370.

Gerhardt, H. C. 1994. The evolution of vocalization in frogs and toads. Annual Review of Ecology and Systematics, 25:293-324.

Gerhardt, H. C. and F. Huber. 2002. Acoustic communication in insects and anurans: common problems and diverse solutions. The University of Chicago Press, Chicago, 531pp.

Haddad, C. F. B., J. G. R. Giovanelli, L. O. M. Giasson, and L. F. Toledo. 2005. Guia sonoro dos anfíbios anuros da Mata Atlântica. Commercial digital media. Manaus: NovoDisc Mídia Digital da Amazônia Ltda.

Heyer, W. R., A. S. Rand, C. A. G. Cruz, O. L. Peixoto, and C. E. Nelson. 1990. Frogs of Boracéia. Arquivos de Zoologia, 31(4):231-410.

Lingnau, R., L. D. Guimarães, and R. P. Bastos. 2004. Vocalização de *Hyla werneri* (Anura, Hylidae) no sul do Brasil. Phyllomedusa, 3(2):115-120.

Lutz, B. 1973. Brazilian species of *Hyla.* University of Texas Press, Austin, 272pp.

Napoli, M. F. and I. C. S. Cruz. 2005. The advertisement call of *Hyla atlantica* Caramachi and Velosa, 1996, with considerations on its taxonomic status (Amphibia, Anura, Hylidae). Arquivos do Museu Nacional, 63(2):283-288.

Pombal Jr., J. P. and R. P. Bastos. 1998. Nova espécie de *Hyla* Laurenti, 1768 do centro-oeste brasileiro e a posição taxonômica de *Hyla microcephala werneri* Cochran, 1952 e *H. microcephala meridiana* B. Lutz, 1952 (Anura, Hylidae). Boletim do Museu Nacional (N.S.) Zoologia, 1998(390):1-14.

Pombal Jr., J. P. and R. P. Bastos. 2003. Vocalizações de *Scinax perpusillus* (A. Lutz and B. Lutz) e *S. arduous* Peixoto (Anura, Hylidae), com comentários taxonômicos. Revista Brasileira de Zoologia, 20(4):607-610.

Pombal Jr., J. P., R. P. Bastos,, and C. F. B. Haddad. 1995. Vocalizações de algumas espécies do gênero *Scinax* (Anura, Hylidae) do sudeste do Brasil e comentários taxonômicos. Naturalia, 20:213-225.

Silva-Filho. I. S. N. and F. A. Juncá. 2006. Evidence of the full species status of the Neotropical leaf-frog *Phyllomedusa burmeisteri baiana* (A. Lutz, 1925) (Amphibia: Anura: Hylidae). Zootaxa, 2006(1113):51-64.

Simon, J. E. and J. L. Gasparini. 2003. Descrição da vocalização de *Phyllodytes kautskyi* Peixoto and Cruz, 1988 (Amphibia, Anura, Hylidae). Boletim do Museu de Biologia Mello Leitão (N. Ser.). 2003(16):47-54.

Straneck, R., E. V. de Olmedo, and G. R. Carrizo. 1990. Catalogo de voces de amfibios argentinos. LOLA, Buenos Aires. 130pp.

Sullivan, B. K. and K. B. Malmos. 1994. Call variation in the Colorado River toad *(Bufo alvarius):* behavioral and phylogenetic implications. Herpetologica, Louisiana, 50(2):146-156.

Sullivan, B. K., K. B. Malmos, and M. F. Given. 1996. Systematics of the *Bufo woodhousii* complex (Anura: Bufonidae): advertisement call variation. Copeia, 1996(2):274-280.

Vielliard, J. 1993. "Side-bands" artifact and digital sound processing. Bioacoustics, 5(2):159-162.

Wells, K. D. 1977. The social behavior of anuran amphibians. Animal Behaviour, 25(3):666-693.

Weygoldt, P. 1981. Beobachtungen zur Fortpflanzungsbiologie von *Phyllodytes luteolus* (Wied, 1824) im terrarium (Amphibidia: Salientia: Hylidae). Salamandra, 17(1/2):1-11.

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